

# ADVAIT MEHLA

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## Education

### Indian Institute of Technology Bombay

(Nov '20 - present)

- Major degree (with Honors) : Bachelors of Technology in Engineering Physics - **CPI : 8.87/10**
- Minor degree : Department of Electrical Engineering

## Scholastic Achievements

- Among the **top 23** students worldwide to be awarded a fully-funded **LIGO-SURF** internship at Caltech ('23)
- Awarded a **Branch Change** to **Engineering Physics** based on exemplary academic performance ('21)
- Secured a percentile of **99.923** among over **1 million** candidates in **JEE Mains** ('20)
- Awarded the **KVPY fellowship** by DST, Govt. of India **twice** with **All India Ranks 306** and **466** ('19, '18)
- Among the **top 450** students nationally selected for **Indian National Physics Olympiad (INPhO)** ('19)

## Publications

- Bala S., Mate S., Mehla A. et al. Prospects of measuring Gamma-ray Burst Polarisation with the Daksha mission ([ArXiv:2306.16781](https://arxiv.org/abs/2306.16781)). Submitted to *JATIS* (2023)
- Bhalerao V., Sawant D., ... , Mehla A. et al. Science with the Daksha High Energy Transients Mission ([ArXiv:2211.12052](https://arxiv.org/abs/2211.12052)). Submitted to *Experimental Astronomy* (2022)

## Key Projects

### Measuring the Polarisation of GRBs with the Daksha mission

(Nov '21 - May '23)

Guides : Prof. Varun Bhalerao, Dept. of Physics IIT Bombay; Dr. Sujay Mate, TIFR Mumbai

Daksha is a proposed space telescope mission consisting of a pair of satellites to act as a high energy all-sky monitor

- Simulated the interactions of photons with detectors using the **Geant4 toolkit** developed by **CERN**
- Created a **pipeline** to construct **response files** for inferring **source spectra** from the detected counts
- Developing and testing a processing pipeline to implement **Compton Polarimetry** with **pixellated detectors** in order to **determine polarisation** of sources and estimate the Minimum Detectable Polarisation
- Work on the polarisation capabilities of Daksha was presented at the *Astrophysical Polarimetry in the Time-Domain Era* conference held at Politecnico di Milano - Lecco, Italy as a poster with me as a co-author

### Demonstrating Optimal Nonlinear Temperature Control

(May '23 - present)

Guide : Prof. Rana Adhikari, California Institute of Technology

- Designed and built **low-noise** temperature sensors and PWM driven heater circuits for the control system
- Implemented a **data acquisition** and **actuation** system using a Raspberry Pi and Waveshare AD/DA Board
- Modelled **heat transfer mechanisms** for an insulated mass and fitted experimental data to obtain parameters
- Successfully implemented **PID temperature control** of a mass and achieved identical performance to simulations
- Exploring **reinforcement learning** based methods of training neural networks for nonlinear control

### Studying an Exoplanetary System with GROWTH-India Telescope | [Report](#)

(Spring '23)

Course Project, PH556: Observational Astrophysics, Prof. Varun Bhalerao, Department of Physics

The GROWTH-India Telescope is a 0.7m robotic transient telescope located at the Indian Astronomical Observatory

- Submitted a **proposal** to take continuous observations of a **transit of WASP-43b** around its host star
- **Reduced images** to compute the evolution of relative flux during the transit using Astropy and Photutils
- Fitted the observed transit data to a model using **Markov-Chain Monte Carlo** method with the **exoplanet** package and **inferred** the planetary radius, impact parameter and mid-transit time **within 1 $\sigma$**  of actual values

### Resonant Mass GW Detectors : Instrumentation & Noise Sources | [Report](#)

(Autumn '22)

Course Project, PH821: Gravitational Wave Astronomy and Physics, Prof. Archana Pai, Department of Physics

- Surveyed literature on resonant bar based gravitational wave detectors and the measurement challenges associated
- Analysed the **electro-mechanical oscillator** system and its transfer function to understand its advantages
- Quantified the **minimal detectable energy** and **noise spectral density** of the dominant noise sources

## Workshops

### Radio Astronomy Winter School | NCRA - TIFR

(Dec '22)

Ten-day offline school consisting of talks and experiments on the fundamentals of radio astronomy

- Attended sessions by renowned experts on topics like radiative processes, techniques and instruments used in radio astronomy, observational radio astronomy, cosmology and fast radio bursts
- Recorded observations of **HI emissions** at different longitudes in the galactic plane with a rudimentary horn antenna and analysed the data to generate a **rotation curve** for the Milky Way

### GEANT4 and its Application to High-Energy Physics and Astrophysics | IUCAA

(Dec '22)

Five-day offline workshop on the applications of GEANT4 for astrophysics and high energy physics instruments

- Attended talks by prominent researchers working on various experiments and missions like CMS, Hyper-K, POLAR, Fermi, Swift and AstroSat and learnt about the instruments and simulation techniques utilised
- Implemented detector systems like **CMS-HGCAL** and a **scattering polarimeter** in GEANT4 from scratch during hands-on tutorial sessions and analysed resulting data using Python and ROOT

## Other Projects

### Simulating Kirkwood Gaps

(July '21 - Sept '21)

Krittika, the Astronomy Club of IIT-B (Summer Project)

- Implemented a **Monte Carlo simulation** to evolve large distributions of asteroids over millions of years
- Observed the emergence of **Kirkwood gaps** in the **asteroid belt** along with features like the Jupiter Trojans
- Optimised simulation times by a factor of **6 to 12** via implementation of **parallelised code** and utilisation of **high performance computing** libraries like **OpenMP** and **CUDA Fortran**

### Team Member, GLEE | IIT Bombay Student Satellite Program

(May '21 - June '22)

A 70+ member student team with the vision of making IIT Bombay a centre of excellence in space technology

- **Instrumentation Subsystem**
  - Scrutinised components & constructed a multi-stage **readout circuit** for a PIN diode based **spectroscope**
  - Tested and verified the functioning of the circuit by simulating input signals & analysing the output waveform
- **Communications Subsystem**
  - Designed several iterations of a 4cm x 4cm **prototype ChipSat** capable of processing and **wirelessly transmitting** data from the **lunar environment** gathered by **two sensors** interfaced with a microcontroller
  - Learnt **embedded C** and implemented **UART**, **SPI** communication protocols to achieve data transmission

### Truly Random Number Generator using Chaos

(Autumn '22)

Course Project, PH435: Microprocessors Lab, Prof. Pradeep Sarin, Department of Physics

- Designed, simulated and constructed a chaotic **Chua circuit** tuned to operate in the double scroll region
- Interfaced the circuit with an Arduino and pre-processed the bitstream using the **von Neumann whitening** algorithm to de-skew the incoming random bits and subjected them to rigorous tests of randomness

### Analysis of the Nonlinear Dynamics of Neuronal Models

(Autumn '21)

Course Project, PH567: Nonlinear Dynamics and Chaos, Prof. Amitabha Nandi, Department of Physics

- Designed and constructed an **analog circuit** to mimic the Nagumo **neuronal model** and demonstrated the **action potential** and other **neuronal behaviour** by visualising signals on a digital oscilloscope
- Explored the **phase space** of the **Fitzhugh model** by numerically integrating the dynamical equations

## Technical Skills

<b>Languages</b>	C/C++, Python, Fortran, MATLAB, $\text{\LaTeX}$
<b>Packages/Libraries</b>	Astropy, NumPy, Matplotlib, SciPy, SymPy, Pandas, Numba, OpenMP, CUDA
<b>Other Software</b>	GEANT4, Git, Proteus, Photoshop, LTspice, EAGLE, Arduino

## Leadership Experience

### Manager | Krittika, the Astronomy Club of IIT Bombay

(June '22 - present)

- Leading a team of **6 conveners** to organise & conduct events to propagate astronomy at IITB and beyond
- Spearheading the development of the **IIT Bombay Observatory** with an initial funding of INR 1.8 million
- Organized the **Krittika Summer Projects**, an **8-week** long program aimed at exposing students to astronomical research & received **100+ applications** along with **international participation** for the first time
- Hosted observing sessions where **500+** students viewed various astronomical objects through telescopes

## Key Courses

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<b>Physics</b>	Observational Astrophysics, Advanced Astrophysics*, Gravitational Wave Astronomy, General Relativity, Quantum Mechanics I & II, Classical Mechanics, Nonlinear Dynamics
<b>Mathematics</b>	Differential Calculus, Integral Calculus, Linear Algebra, Complex Analysis, Differential Equations I, Differential Equations II, Numerical Analysis
<b>Electronics</b>	Basic Circuits Lab, Op Amp Circuits Lab, Digital Electronics Lab, Microprocessors Lab, Digital Systems, Electronic Devices, Signal Processing, Image Processing, Machine Learning

## Extracurricular Activities and Interests

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*\*To be completed by Nov '23*

- Awarded [NASA Astronomy Picture of the Day](#) for processing raw data from the Hubble Space Telescope ('20)
- Captured images of several **deep sky objects** using basic equipment as an **amateur astrophotographer**
- Awarded a **cash prize** and an **internship offer** as **sole winner** out of **20+** teams in the **Astronomy General Championship** conducted by Nayam Innovations and Institute Technical Council, IITB ('22)
- Attended the 3-day **Vijyoshi National Science Camp** conducted at **IISc Bangalore** for facilitating interactions between KVPY Fellows and world-renowned researchers from various fields of science ('19)